

Strain Imaging for Assessment of Left Ventricular Systolic Function

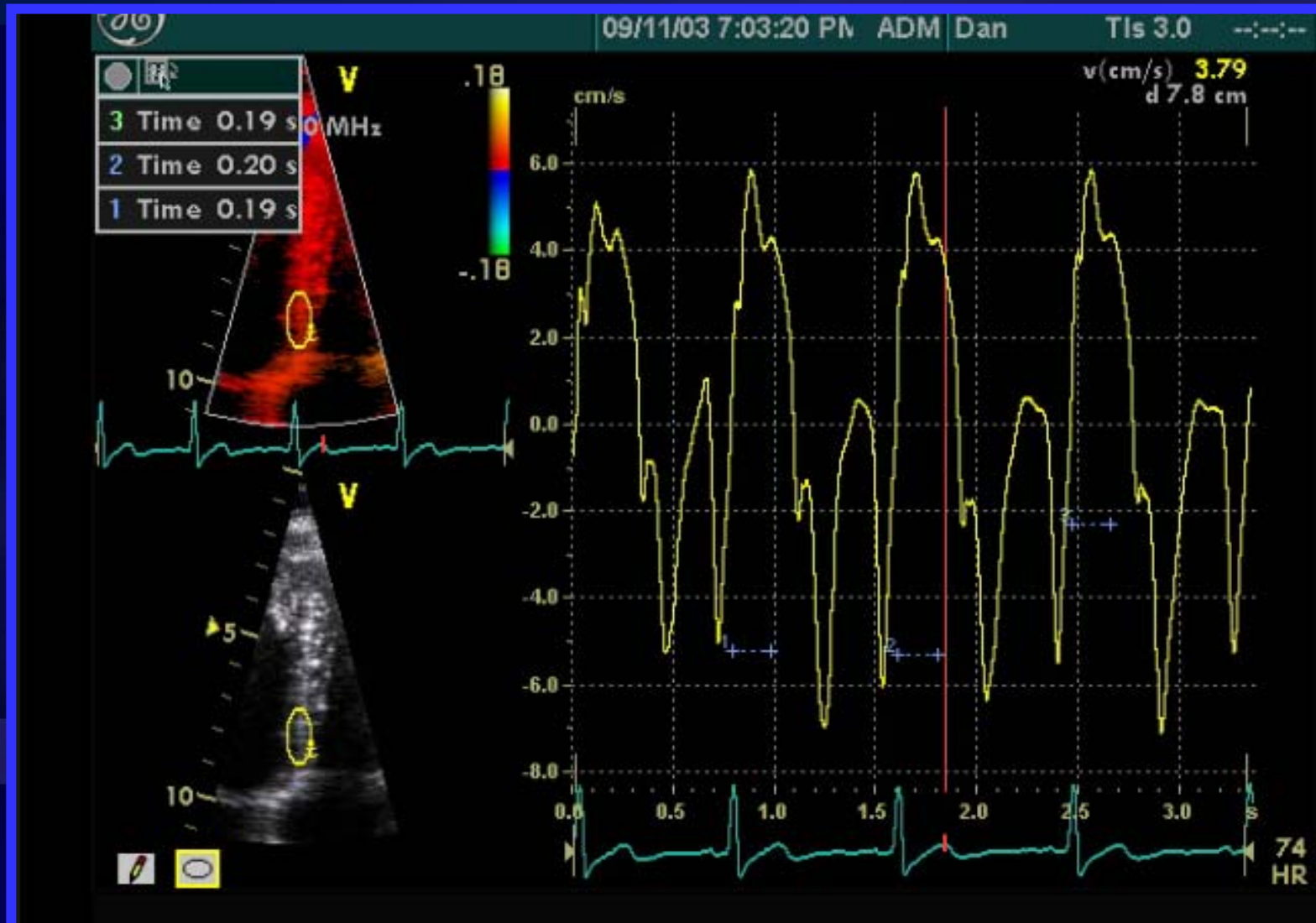
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Doppler Myocardial Imaging (DMI)

**Tissue Doppler Imaging
with Sample Volume placed
in Cardiac Muscle**

Tissue Velocity Imaging

Time to Peak Velocity



Strain Imaging
for Assessing
Ventricular Function

What is Myocardial Strain?

Myocardial Strain

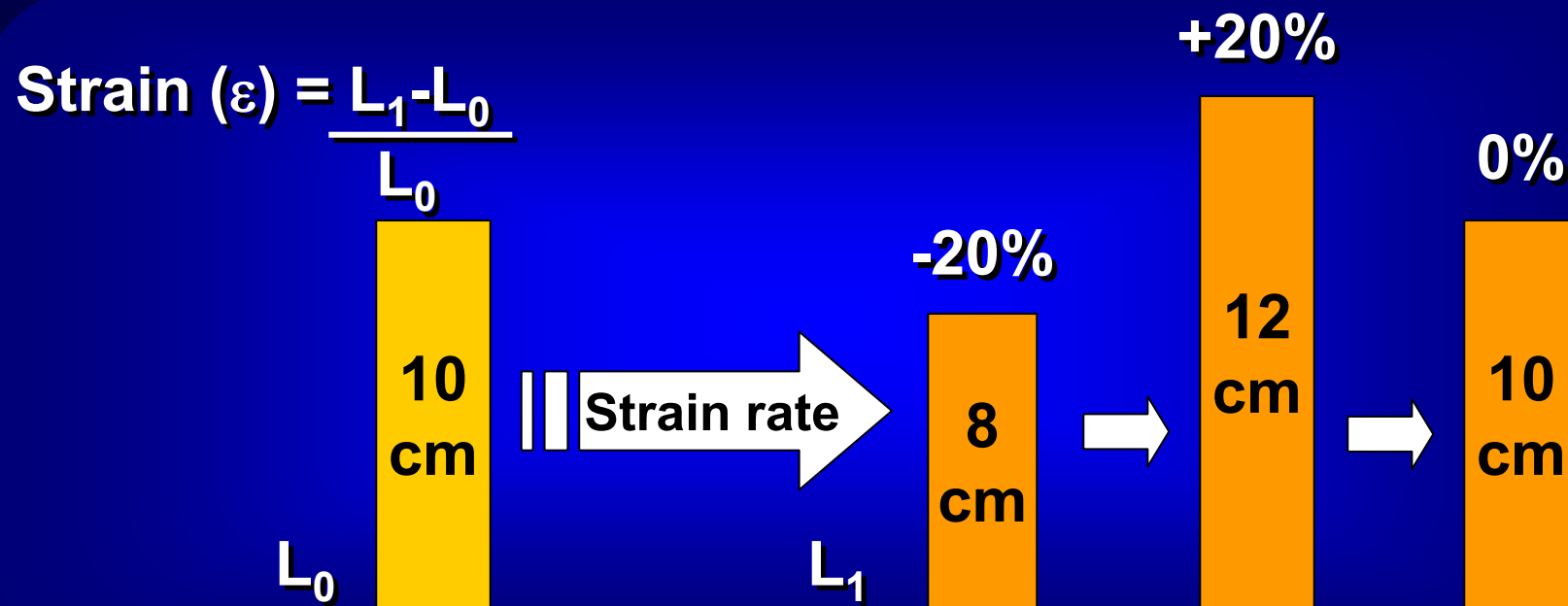
- **Relative deformation of myocardium during contraction and relaxation**
- **Dimensionless quantity**
- **Percent change in length, compared to resting state**

Myocardial Strain

- With contraction, the myocardium is compressed or shortened:
Negative strain
- Lengthening or relaxation:
Positive strain

Myocardial Strain

Used to describe elastic properties of cardiac muscle



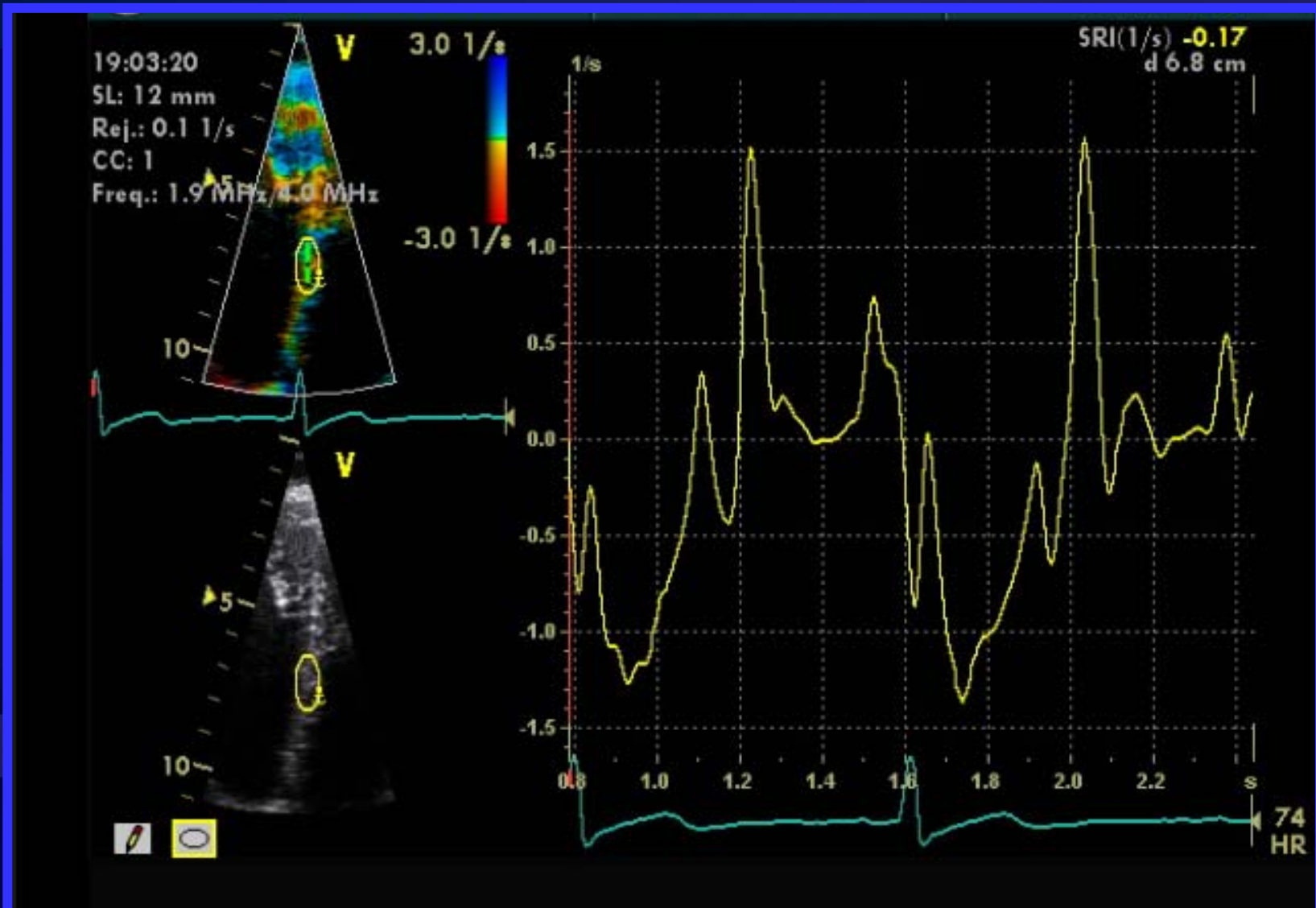
Mirsky and Parmley: Circ Res, 1973

Echocardiography

Strain Rate (SR)

$$SR = \frac{\text{Velocity}_1 - \text{Velocity}_2}{\text{distance}}$$

Strain Rate



Strain

Integral



Derivative

Strain Rate

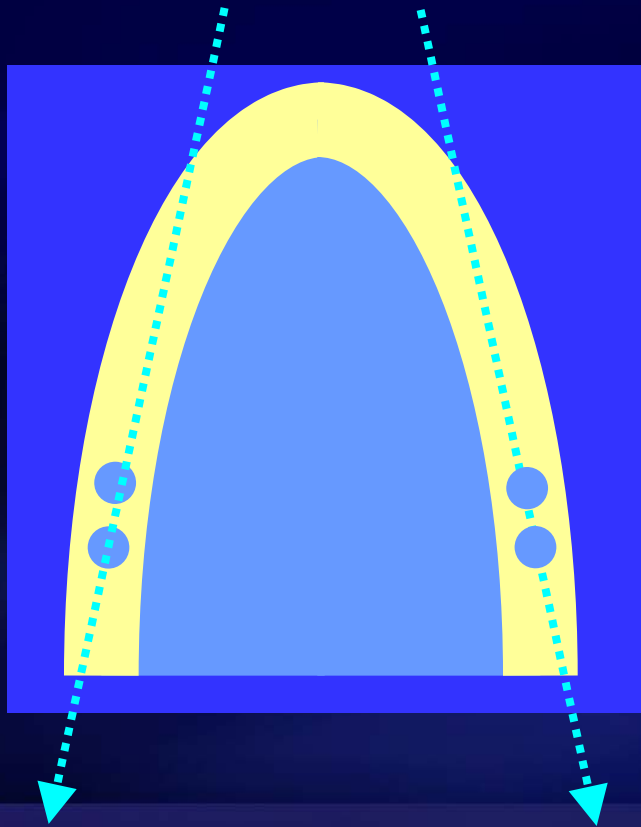
**As Opposed to
Tissue Velocity Imaging,
Strain and Strain Rate Imaging
can Discriminate between
Actively Contracting Muscle
and Muscle that is Moving
because of Tethering**

***When Assessing
Myocardial Function
Strain and Strain Rate
Can be Measured
in many
Different Directions***

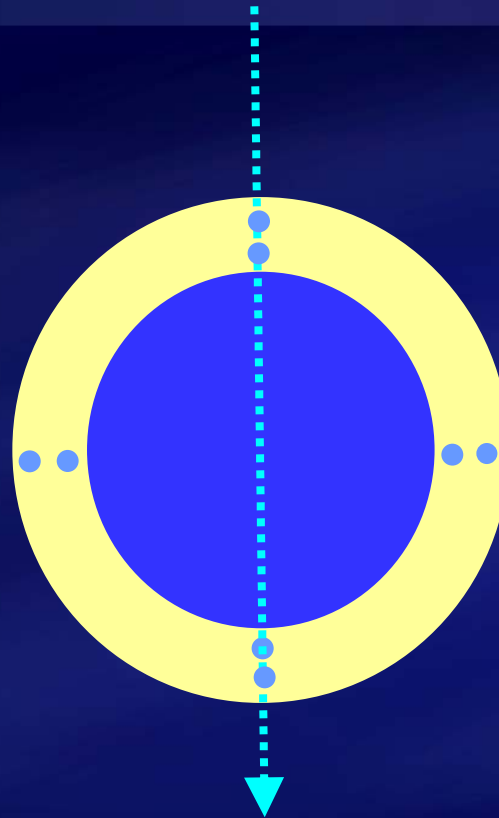
Strain and Strain Rate Imaging

- Longitudinal (apical views)
- Radial (parasternal short axis views)
- Circumferential (parasternal short axis views)
- Transmural (difference between subendocardial and subepicardial strain or strain rate)
- Twist (basal and apical short axis views)

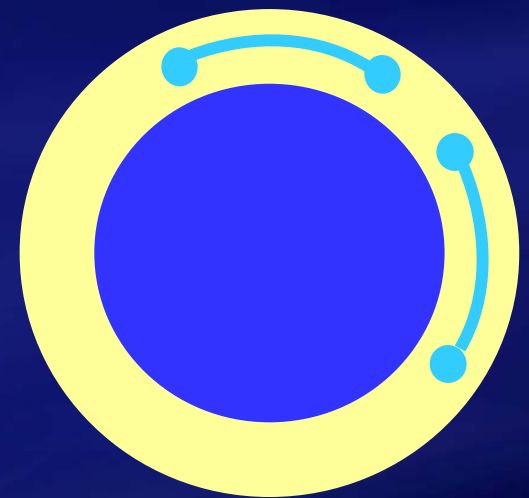
Directions of Cardiac Strain



Longitudinal



Radial



Circumferential

Courtesy of Chinami Miyazake, MD

Doppler Myocardial Imaging



- Angle dependent
- High frame rate (≈ 200 fps)

Doppler Myocardial Imaging

What Have We Learned?

Average Peak Longitudinal Peak Systolic Strain

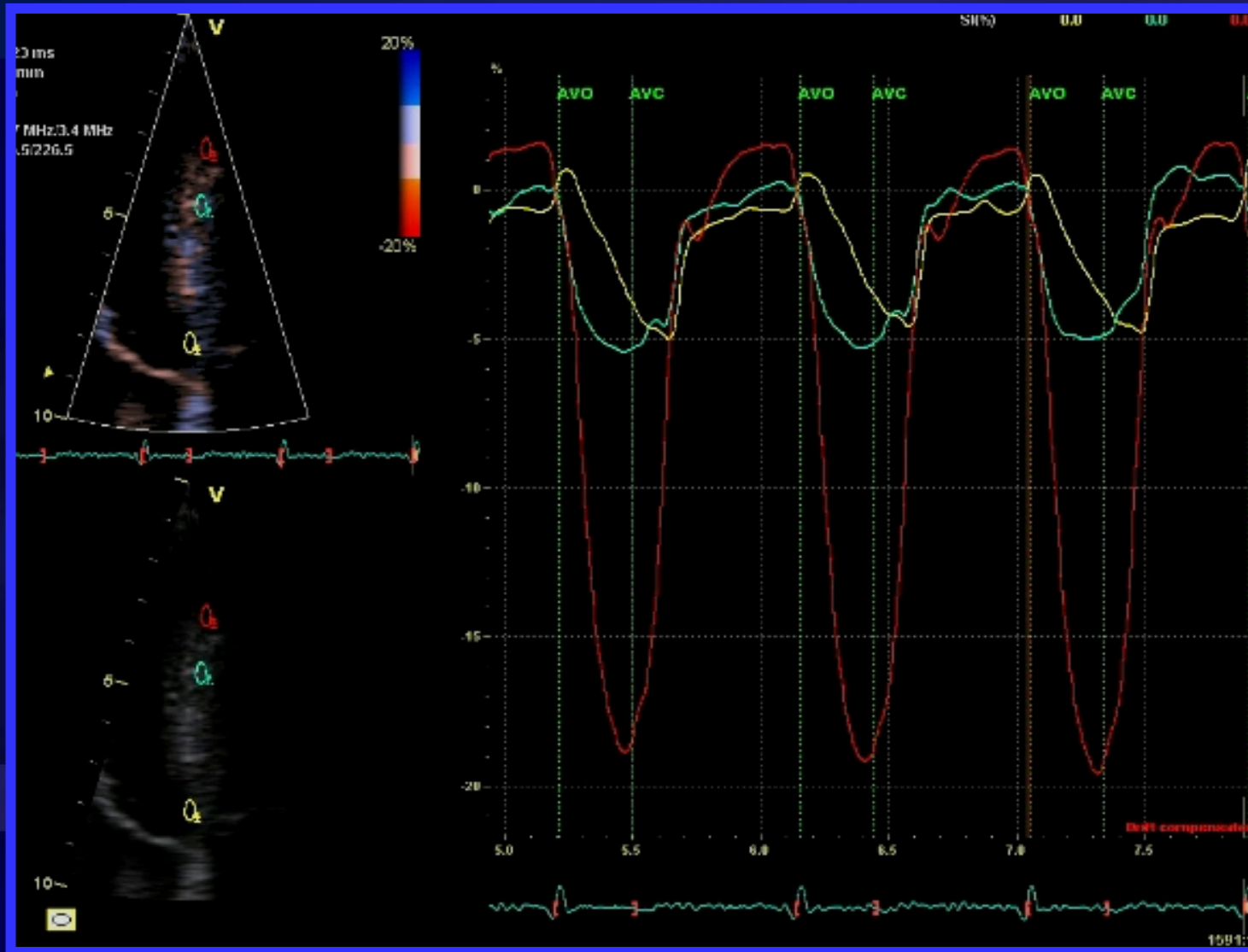
16 LV Segments

- Normal = greater than (more negative than) -18%
- Borderline = -16% to -18%
- Abnormal = less than (less negative than) -16%

Bellavia D; Am J Cardiol; 4/08

**For Diseases that
Diffusely Affect
the Myocardium
Longitudinal Function
May Fail Before
Radial Function (EF)**

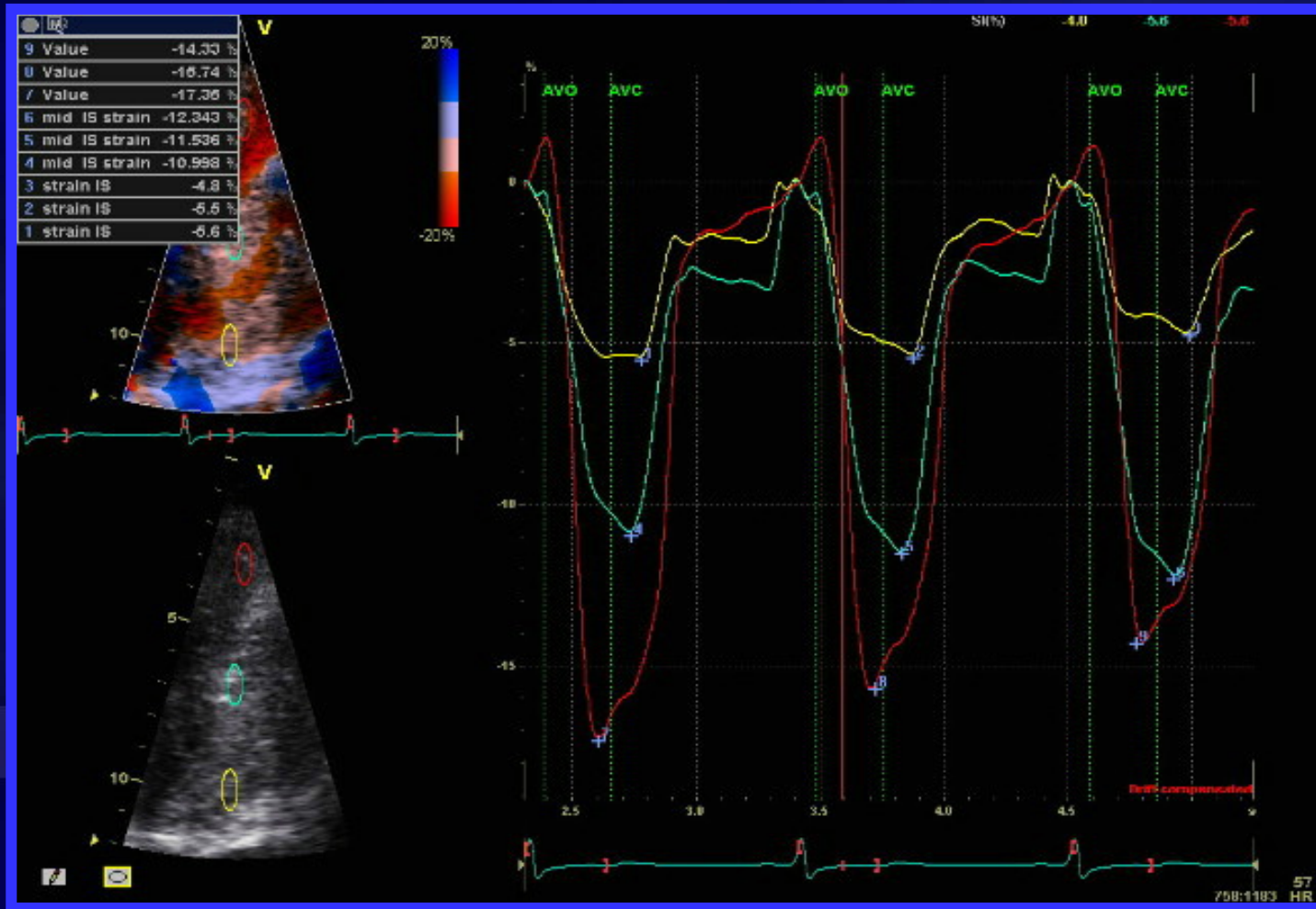
Strain



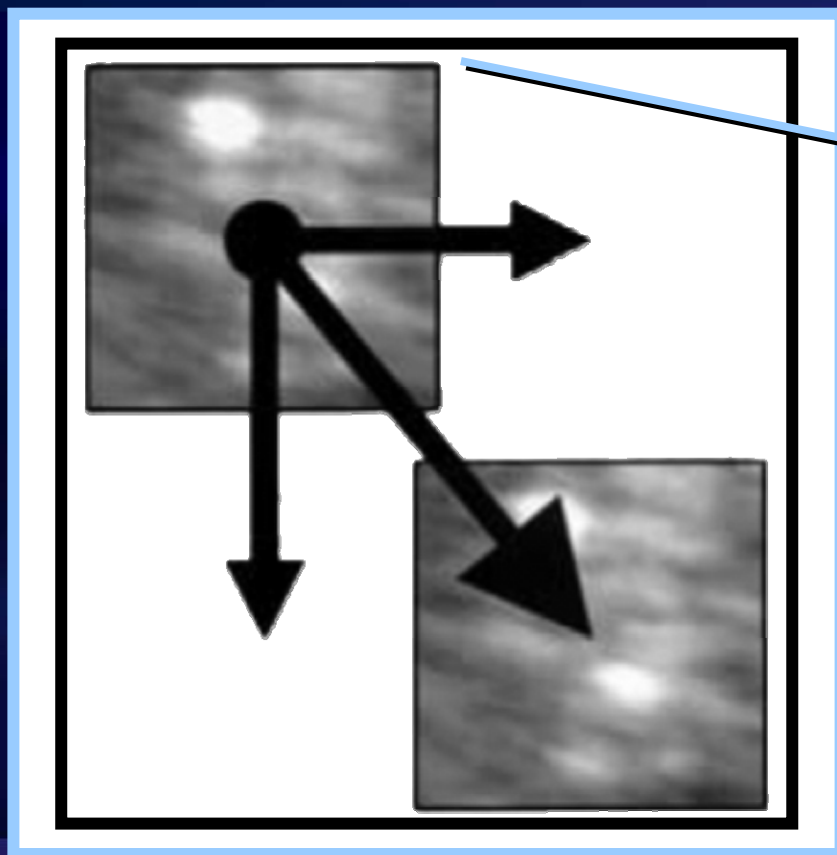
**Normal LVEF
Does Not Always
Mean That
Systolic Function
Is Normal!**

**Doppler Myocardial Imaging
for
Hypertrophic Cardiomyopathy**

Typical HCM Strain



Speckle Tracking for Myocardial Strain

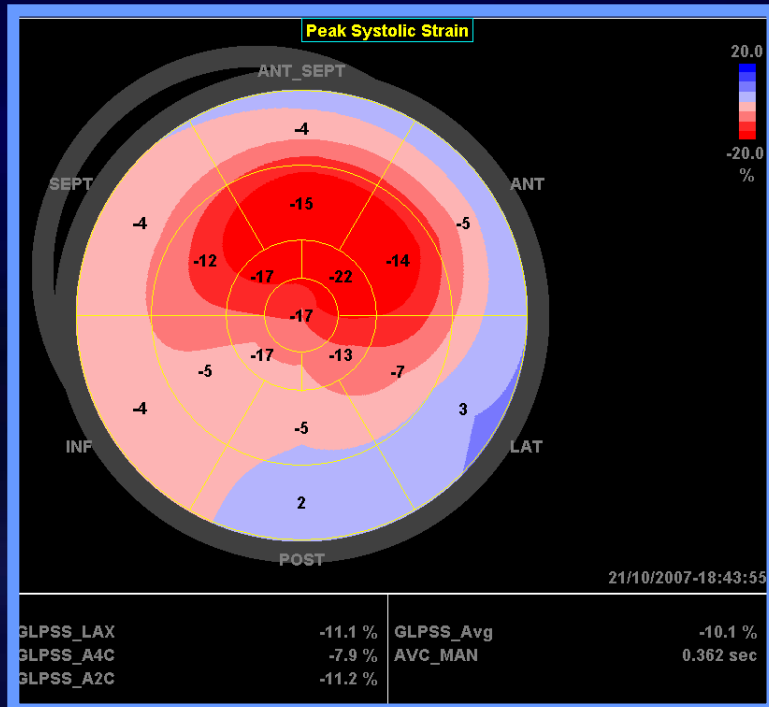


ROI in image at t_0

Search area in image at t_1

Best match in image at t_1

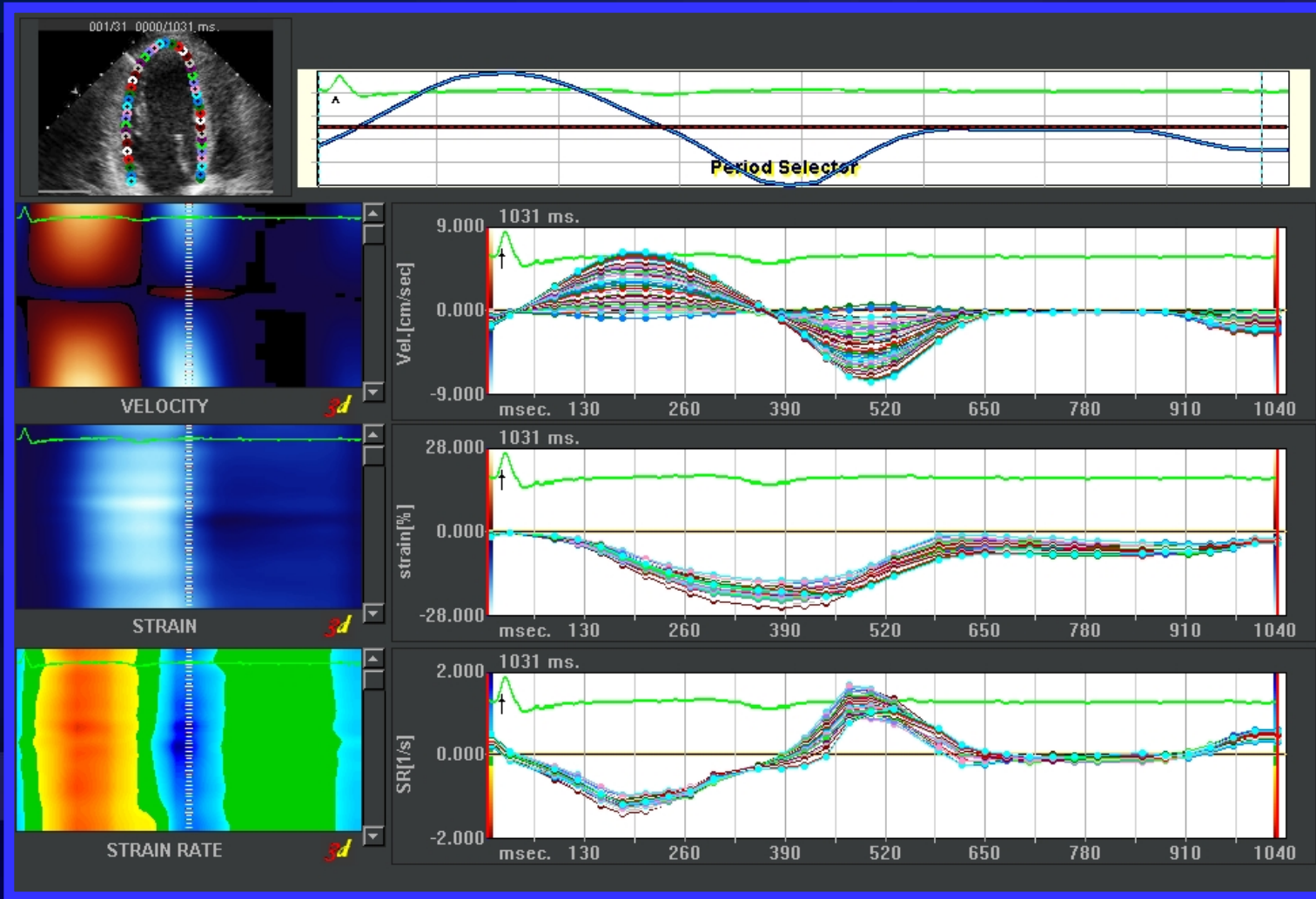
2D Strain



- Not angle dependent
- 50-100 fps
- Auto border detection
- Probably more reproducible than DMI

Velocity Vector Imaging

Velocity Vector Imaging



Left Ventricular Twist and Torsion

- LV empties like twisting wet towel
- Base twists clockwise in systole
- Apex twists counterclockwise in systole
- Torsion is obtained by subtracting basal twist from apical twist

Strain Imaging

- **We offer strain imaging for select patients in our daily practice**
- **Cardiac amyloid**
- **Hypertrophic cardiomyopathy**
- **Other LV muscle diseases**

Strain Imaging

- **Dedicated area for off line analysis**
- **Sonographers and echocardiographers with expertise in strain imaging and strain interpretation**
- **Focus on longitudinal peak systolic strain**

We Have Converted to
2D Strain
as the Primary
Modality for Assessing
Longitudinal Function

**We continue to use Doppler
Myocardial Imaging as a
back-up technique**

Which of the following is/are correct for left ventricular strain?

- A. It is a measure of myocardial deformation**
- B. The unit is %**
- C. Normal longitudinal systolic strain is negative**
- D. It is less affected by tethering than myocardial velocity**
- E. All of the above are true**

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